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Shot-Noise Characteristics of NbN Superconducting Tunnel Junctions

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***Abstract*—An 0.5-THz superconductor-insulator-superconductor (SIS) mixer incorporating with all-NbN superconducting tunnel junctions has been developed and put into real astronomical applications [1]. Even with a measured receiver noise temperature down as low as five times the quantum limit ($5h\nu/k_B$), this NbN SIS mixer doesn't demonstrate reasonably good direct-detection behavior as conventional Nb SIS mixers. It is thought that the enhanced shot-noise due to the MAR (multiple Andreev reflection) effect [2] is considerably larger in direct detection than in heterodyne mixing. To better understand this difference, in this paper we mainly investigate the shot-noise characteristics of NbN superconducting tunnel junctions. Firstly, the power spectral density of the shot noise resulting from 0.5-THz NbN twin SIS junctions is measured with respect to the dc bias voltage by a low-frequency (~100 Hz) and high-frequency (a few GHz) method. The measured results are compared with simulated ones to understand how the shot noise is enhanced by the MAR effect. Secondly, the direct-detection and heterodyne mixing characteristics of the 0.5-THz NbN twin SIS junctions are measured and compared. Detailed experimental and simulation results will be presented.**

1. Jing Li, Masanori Takeda, Zhen Wang, Sheng-Cai Shi, and Ji Yang, Appl. Phys. Lett., vol. 92, 222504, June 2008.
2. P. Dieleman, H. G. Bukkems, T. M. Klapwijk, M. Schicke, and K. H. Gundlach, Phys. Rev. Lett., vol. 79, pp. 3486-3489, Nov. 1997.